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'STRSDIST' USERS GUIDE: COMPUTER CALCULATION OF HYPOTHETICAL STRESS DISTRIBUTION IN A RIB-SIDE

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March 1985

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23pp

ENERGY RESEARCH PROGRAM
COAL RESEARCH LABORATORIES
DIVISION REPORT ERP/CRL 85-25(TR)

MICROMEDIA

'STRSDIST' USERS GUIDE

by

P. Cain*

ABSTRACT

A hypothetical method of calculating stress rise in the ribside of a horizontal longwall coal panel has been computerised in the form of the programme 'STRSDIST'. This report describes the programme written in PRO/Basic VI.0 for a Digital Professional 350 microcomputer.

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LE GUIDE DES UTILISATEURS DU PROGRAMME 'STRSDIST'

par

Peter Cain*

RÉSUMÉ

On a automatisé une méthode hypothétique qui sera connue sous l'appellation de Programme 'STRSDIST' pour calculer la formation de contraintes dans le pilier d'un panneau horizontal d'une longue taille de charbon. Le rapport présente le programme qui a été écrit en langage PRO/BASIC V1.0 en fonction du mircrprocesseur Digital Professional 350.

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INTRODUCTION

Some estimate of the distribution of stress in pillars between longwall panels is required if the mining engineer is to produce quantitative estimates of the required pillar width and assist in the siting of roadways. One method of calculating the distribution of stress in the pillars has been proposed by Wilson (1), based on observation and measurement over a number of years in coal mines in the United Kingdom.

The program 'STRSDIST' uses Wilson's method to calculate the stress distribution in a rib pillar adjacent to a longwall panel in horizontal strata. This report is confined to the operation of the computer programme on a Digital Professional 350 microcomputer, with a 10Mbyte Winchester Hard Disk running P/OS version 1.7. Additional software required is Pro/BASIC Version 1.0. Printer output is to an LA100PC. The user is expected to be familiar with the method of stress calculation and the operation of the PRO/350 microcomputer.

The programme will run on the configuration given above. A source listing, and examples of output are included in the report, which describes the various programme segments.

PROGRAMME DESCRIPTION

Variable names have been chosen to reflect the parameter they represent. Double precision is defined at the start of the program (Appendix A).

10 - 300	Header and programme preamble.
310 - 370	Internal read of default data values.
380 - 620	Interactive confirmation of acceptable default data values. Defaults may be changed, but are not stored.
630 - 690	Input depth and width of panel.
700 - 880	Interactive selection of output types required, Printer, File or both may be chosen. File output

	is to the selected file name with the extension 'DAT' on the device and directory containing the programme.
890 - 1060	Calculation of constants used in the determination of hypothetical vertical stress. The code reflects the same assumptions and conditions put forward by Wilson.
1070 - 1580	Open the selected output devices for output. Lines 1120-1570 set printer characteristics and produce output headers using parameter values calculated in lines 8903-1060.
1590 - 1690	Calculates the stress distribution at distances from the ribside entered at line 870. Line 1680 transfers to the output subroutine.
1700 - 1720	Output terminators and printer parameter reset to default.
1730 - 1770	Close files, signify operation, complete and stop.
1780 - 1870	Output subroutine. Printer-graph scale is selected automatically at line 1040 which sets the value of the variable SCALE% to produce a stress axis of 0-200 MPa based on the value determined for the abutment stress, designated SIGCAP. Output to file results in record for each depth increment, each record having two fields of ten spaces with three after the decimal point. These numeric fields are separated by a comma (,).

EXAMPLE TERMINAL SESSION

On execution of the appropriate command, the terminal will respond as shown in Figure 1(a). To continue programme execution, press the carriage return key.

The next stage is to confirm or change the value of the default parameters. Each parameter and its default value are displayed line by line. Press the carriage return key to accept the default value or type in

an alternate, using the same units, followed by a carriage return. In the example shown in Figure 1(b), the intact coal strength has been charged to 11MPa and the strength factor i.e. the amount by which the laboratory determined intact strength must be divided to reflect the in situ strength has been changed to 4. The default yield criterion was chosen.

The programme then asks for mining parameters as shown in Figure 1(c).

Selection of output types [Figure 1(d)] is followed by the selection of incremental increase of depth into the pillar for the stress calculations, I, and the number of increments to be calculated, [Figure 1(e)]. A large value for N will tie up the printer for some time and may result in an error if there is not enough room on the disk for the output file.

REFERENCES

1. Wilson, A.H. "The stability of underground workings in the soft rocks of the coal measures"; Int. Journal of Mining Engineering; 1983, 1, No. 2, pp. 91-187; Ed. I.W. Farmer; Pub: Chapman and Hall.

To begin programme operation, you must first set up the parameters to be used in calculating the hypothetical stresses.

Suggested values for each of the data required, are given, but if you wish to use other values you may do so.

If you are unsure about any of the parameters, you are advised to become familiar with the method of calculating stress rise in rib pillars proposed by A.H. Wilson. A reference to his work can be found in 'STRSDIST.DOC'

To continue press < CR >

1(a)

Figure 1 - Sample terminal session

```
  Set data values as prompted.  Type < CR > to
  accept default values as given in brackets
Strata Density                    ( 2600 kg/m^3)
Intact Coal Strength              ( 35 MPA)        11
Failed Coal Strength              ( .2 MPA)
Triaxial Stress Factor            ( 4 )
Extracted Height                  ( 3.6 m )
Lateral Support Resistance        ( .1 MPa )
Strength Factor                   ( 5 )            4

 Now select a yield criterion: < 0 > for roof only,
      <1> for yield in roof, seam and floor.

 Yield Criterion                  ( 1 )
```

1(b)

Figure 1 - Sample terminal session (cont'd)

```
Give the panel depth in metres:  500
Give the panel width in metres:  200

1(c)

        Now specify the output you require in the following
        Format:  type < 1 > for printer output, < 2 > for output
                 to a sequential file or < 3 > for both
                   What output do you require? < 1 >

1(d)
```

Figure 1 - Sample terminal session (cont'd)

Please give the pillar increment of horizontal distance you
wish to use for the stress calculations, and the total number
of increments you want to calculate in the form I,N
when prompted

Remember that this will control the size of your output
Give values of I and N now: 1,50

1(e)

Figure 1 - Sample terminal session (cont'd)

APPENDIX A
'STRSDIST' SOURCE LISTING
AND STRSDIS.DOC FILE

```
SET DOUBLE
10 REM ************************************************************************
20 REM
30 REM                        PROGRAM 'STRSDIST'
40 REM                        ******************
50 REM
60 REM                Written by:       Peter Cain
70 REM                                  Research Scientist (Strata Control)
80 REM                                  Department of Energy, Mines & Resources
90 REM                                  CANMET CRL Cape Breton
100 REM                                 210 George Street
110 REM                                 Sydney, N.S.
120 REM                                 CANADA   B1P 1J3
130 REM
140 REM ************************************EXPLAIN AND INPUT SET-UP PARAMETER
150 REM
160 CLEAR   PRINT \ PRINT
170 PRINT                    To begin programme operation, you must first set'
180 PRINT                     up the parameters to be used in calculating the'
190 PRINT                                  hypothetical stresses.' \ PRINT
200 PRINT                     Suggested values for each of the data required,'
210 PRINT                     are given, but if you wish to use other values'
220 PRINT                                     you may do so.' \ PRINT \ PRINT
230 PRINT                      If you are unsure about any of the parameters,'
240 PRINT                        you are advised to become familiar with the'
250 PRINT                     method of calculating stress rise in rib pillars'
260 PRINT                        proposed by A.H.Wilson. A reference to his'
270 PRINT "                          work can be found in  STRSDIST.DOC'"
280 PRINT \ PRINT
290 PRINT '                                  To continue press <CR>';\ INPUT #0,A$
300 REM
310 REM ************************************************ SET DEFAULT DATA VALUES
320 REM
330 DATA 2600,25,.2,4,3.6,2.0,0.1,5,1
340 READ DENS,SIG0,SIGF,TXLSF,M,SEAM,SPES,XSIG0,CRIT%
350 RESTORE
360 REM
370 REM ********************************** CHECK DEFAULTS & AMMEND IF NECCESSARY
380 REM
390 CLEAR   PRINT   PRINT
400 PRINT            Set data values as prompted. Type <CR> to accept default'
410 PRINT                          values as given in brackets   PRINT \ PRINT
420 PRINT 'Strata Density              ';DENS; kg/m^3) ';: INPUT #0%,DENSI
430 IF DENSI>0 THEN DENS=DENSI
440 PRINT  Intact Coal Strength        ';SIG0;' MPa)      ';\ INPUT #0%,SIG0I
450 IF SIG0I>0 THEN SIG0=SIG0I
460 PRINT 'Failed Coal Strength        ';SIGF;  MPa)      ';  INPUT #0%,SIGFI
470 IF SIGFI>0 THEN SIGF=SIGFI
480 PRINT 'Triaxial Stress Factor      ';TXLSF;')         ';  INPUT #0%,TXLSFI
490 IF TXLSFI>0 THEN TXLSF=TXLSFI
500 PRINT  Height of Gateroad          ';M;  m)         ;  INPUT #0%,MI
501 IF MI>0 THEN M=MI
505 PRINT  Height of Seam              ';SEAM;  m)        ';  INPUT #0%,SEAMI
510 IF SEAMI>0 THEN SEAM=SEAMI
```

```
520 PRINT 'Lateral Support Resistance  ( ;SRES;  MPa)      ;\ INPUT #0%,SRESI
530 IF SRESI>0 THEN SRES=SRESI
540 PRINT 'Strength Factor             ( ;XSIG0;')         ;\ INPUT #0%,XSIG0I
550 IF XSIG0I>0 THEN XSIG0=XSIG0I
560 PRINT   PRINT
570 PRINT '                  Now select a yield criterion: (0) for seam only,'
580 PRINT '                      (1) for yield in roof, seam and floor.' \ PRINT
590 PRINT 'Yield Criterion           ( ;CRIT%;')          ;  INPUT #0%,CRITI%
600 IF CRITI%<>CRIT% THEN CRIT%=CRITI%
610 CLEAR \ PRINT   PRINT
620 REM
630 REM ***********************************************ENTER MINING PARAMETERS
640 REM
650 PRINT '          Give the panel depth in metres: ';
660 INPUT #0%,H  PRINT   PRINT
670 PRINT '          Give the panel width in metres: ';
680 INPUT #0%,W  PRINT   PRINT
690 REM
700 REM ******************************************REQUEST OUTPUT SPECIFICATIONS
710 REM
720 CLEAR \ PRINT   PRINT
730 PRINT '                  Now specify the output you require in the following'
740 PRINT '                  format: type (1) for printer output, (2) for output'
750 PRINT '                       to a sequential file or (3) for both'\ PRINT
760 PRINT '                    What output do you require?   ';\ INPUT #0%,OUT%
770 IF OUT%=1% THEN GOTO 810
780 PRINT   PRINT
790 PRINT '                   Please give the name of the output file, excluding'
800 PRINT '                      the 3-character file type    ;\ INPUT #0%,OUTPUT$
810 CLEAR   PRINT   PRINT
820 PRINT '      Please give the pillar increment of horizontal distance you'
830 PRINT '     wish to use for the stress calculations, and the total number'
840 PRINT '          of increments you want to calculate in the form I,N'
850 PRINT '                                 when prompted'\ PRINT
860 PRINT '        Remember that this will control the size of your output'
870 PRINT \ PRINT '                Give values of I and N now;  ';\ INPUT #0%,I,N
880 REM
890 REM ***********************************************CALCULATION OF CONSTANTS
900 REM
910 SUPP=SRES+(SIGF/(TXLSF-1%))
920 DENS=(DENS*9.81)/.1E+07
930 F=((TXLSF-1%)/(TXLSF^.5))+((TXLSF-1%)/(TXLSF^.5))^2%)*ATN(TXLSF^.5)
940 STRESS=DENS*H
950 IF W/=(H*.6) THEN GOTO 970
960 AW=(.5*(W*DENS))*(H-(W/1.2))\ GOTO 980
970 AW=.15*DENS*(H^2%)
980 IF CRIT%=1% GOTO 1010
990 XB(CRIT%)=(SEAM/F)*LOG(STRESS/SUPP)
1000 AB(CRIT%)=(SEAM/F)*(TXLSF*(STRESS-SUPP))\ GOTO 1030
1010 XB(CRIT%)=(H^2%)*(((STRESS/SUPP)^(1%/(TXLSF-1%)))-1%)
1020 AB(CRIT%)=(H/2%)*SUPP*(((STRESS/SUPP)^(TXLSF/(TXLSF-1%)))-1%)
1030 SIGCAP=(TXLSF*STRESS)+(SIG0/XSIG0)
1040 IF SIGCAP<100% THEN SCALE%=2% ELSE SCALE%=1%  REM SET LP: OUTPUT SCALE
1050 C=(AW+(STRESS*XB(CRIT%))-AB(CRIT%))/(SIGCAP-STRESS)
1060 REM
```

```
1070 REM **********************OPEN OUTPUT UNITS AND INITIALISE LP: IF REQUIRED
1080 REM
1090 IF OUT%=1% THEN OPEN "LP:" FOR OUTPUT AS FILE #1%
1100 IF OUT%=1% THEN OPEN OUTPUT$ FOR OUTPUT AS FILE #2%
1110 IF OUT%=2% GOTO 1610
1120 PRINT #1%,CHR$(27%)+"[4W" REM SET 132ch PRINT WIDTH ON LA100
1130 PRINT #1%,CHR$(27%)+"[2""z" REM SET QUALITY TO LETTER MODE
1140 PRINT #1%,TAB(49%);"STRESS DISTRIBUTION IN THE RIBSIDE"
1150 PRINT #1%,TAB(49%);"************************************"
1160 PRINT #1%" PRINT #1%
1170 PRINT #1%,TAB(49%); PARAMETER";TAB(73%);"VALUE" PRINT #1%
1180 PRINT #1%,TAB(49%);"DENSITY ";TAB(73%);DENS;" MPa m^3"
1190 PRINT #1%,TAB(49%);" DEPTH ";TAB(73%);H;" m"
1200 PRINT #1%,TAB(49%);" WIDTH ";TAB(73%);W;" m"
1210 PRINT #1%,TAB(49%);"EXTD. HT. ";TAB(73%);M;" m"
1220 PRINT #1%,TAB(49%);"COAL STR. (I) ";TAB(73%);SIC0;" MPa"
1230 PRINT #1%,TAB(49%);"COAL STR. (F) ";TAB(73%);SICF;" MPa"
1240 PRINT #1%,TAB(49%);"LAT SUPP RES ";TAB(73%);SRES;" MPa"
1250 PRINT #1%,TAB(49%);"STR FACTOR ";TAB(73%);XSIC0
1260 PRINT #1%,TAB(49%);"STRESS FCTR ";TAB(73%);TXLSF
1270 PRINT #1% PRINT #1%
1280 IF CRIT%=1% THEN GOTO 1310
1290 PRINT #1%,TAB(49%); "********** YIELD IN COAL ONLY **********"
1300 GOTO 1320
1310 PRINT #1%,TAB(49%); "*****" YIELD IN COAL ROOF AND FLOOR *****"
1320 PRINT #1% PRINT #1%
1330 PRINT #1%,TAB(58%); CALCULATED VALUES"
1340 PRINT #1%,TAB(58%); *****************" PRINT #1% PRINT #1%
1350 PRINT #1%,TAB(49%);"PARAMETER ";TAB(73%);"VALUE" PRINT #1%
1360 PRINT #1%,TAB(49%);"VIRGIN STRESS ";TAB(73%);STRESS;" MPa"
1370 PRINT #1%,TAB(49%);" YLD ZN WIDTH ";TAB(73%);XB(CRIT%);" m"
1380 PRINT #1%,TAB(49%); ABTMNT STRS ";TAB(73%);SIGCAP;" MPa"
1390 PRINT #1%,TAB(49%); DECAY FCTR (C) ";TAB(73%);C\ PRINT #1%\ PRINT #1%
1400 PRINT #1%,CHR$(12%) REM FORMFEED
1410 PRINT #1%,CHR$(27%)+"[22" REM SET 8 l.p.i. ON LA100
1420 PRINT #1%,CHR$(27%)+"[88t" REM SET FORM LENGTH TO 88 LINES
1430 PRINT #1%,TAB(38%);"VERTICAL STRESS (MPa)";TAB(106%);"X";TAB(123%);"SIGX"
1440 PRINT #1% PRINT #1%
1450 FOR MOVE%=0% TO 100% STEP 10%
1460     PRINT #1%,TAB(MOVE%);MOVE%*SCALE%;
1470 NEXT MOVE% PRINT #1%
1480 FOR K%=1% TO 2%
1490     FOR MOVE%=0% TO 100% STEP 10%
1500         PRINT #1%,TAB(MOVE%);"*";
1510     NEXT MOVE%
1520 PRINT #1%
1530 NEXT K%
1540 FOR MOVE%=0% TO 100% STEP 1%
1550     PRINT #1%,TAB(MOVE%);"*";
1560 NEXT MOVE%
1570 PRINT #1%
1580 REM
1590 REM ****************************************CALCULATE STRESS DISTRIBUTION
1600 REM
1610 FOR J%= TO (I-H) STEP I
```

```
1620     IF X>XB(CRIT%) GOTO 1670
1630     IF X=XB(CRIT%) THEN SIGX=SIGCAP GOTO 1680
1640     IF CRIT%=1% GOTO 1660
1650     SIGX=(SUPP*TXLSF*EXP(X*(F/SEAM)))   GOTO 1680
1660     SIGX=TXLSF*SUPP*(((X+(M/2%))-((M/2%))^(TXLSF-1%)))   GOTO 1680
1670     SIGX=(SIGCAP-STRESS)*EXP((XB(CRIT%)-X)/C)+STRESS
1680     GOSUB 1800  REM       GOTO OUTPUT SUBROUTINE
1690 NEXT X
1700 IF OUT%=2% THEN GOTO 1750 ELSE PRINT #1%,CHR$(12%),CHR$(12%)
1710 PRINT #1%,CHR$(27%)+"@"+CHR$(27%)+"(10E"   REM  RESET LA100
1720 REM
1730 REM ***************************************************CLOSE OUTPUT FILES AND STOP
1740 REM
1750 CLOSE   CLEAR   PRINT  Output is now complete.
1760 STOP
1770 REM
1780 REM ***********************************************************OUTPUT SUBROUTINE
1790 REM
1800 IF OUT%=2% GOTO 1830
1810 PRINT #1%, " ";TAB(INT(SIGX)/SCALE%-1%); " ";TAB(105%);X;TAB(120%);SIGX
1820 IF OUT%=1% THEN RETURN
1830 PRINT #2% USING  ######.###",X;  PRINT #2%,",";
1840 PRINT #2% USING  ######.###",SIGX
1850 RETURN
1860 REM
1870 REM ***********************************************************END OF PROGRAMME
```

```
                    PROGRAM  STRSDIST
                    ****************

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    PROGRAMME TO CALCULATE THE STRESS DISTRIBUTION
     IN THE RIBSIDE OF A LONGWALL PANEL IN A HORIZ-
          ONTAL COAL SEAM ACCORDING TO THE
       HYPOTHESIS PRESENTED BY A.H. WILSON IN:

  "STABILITY OF UNDERGROUND WORKINGS IN SOFT ROCKS OF
                THE COAL MEASURES"

       INTERNATIONAL JOURNAL OF MINING ENGINEERING
       VOLUME 1 NUMBER 2 JULY 1983

  EDITOR: IAN W. FARMER      PUBLISHED: CHAPMAN AND HALL)
                ISSN 0263-4546

  THE PROGRAM INCLUDES DEFAULT VALUES FOR PARAMETERS SUCH
 AS COAL STRENGTH, SUPPORT RESISTANCE AND THE VALUE OF THE
  TRIAXIAL STRESS FACTOR, BUT THESE CAN BE CHANGED AT RUN
  TIME BY A SIMPLE INTERACTIVE PROCESS. MINING PARAMETERS
       ARE ENTERED AT RUN TIME BY THE SAME PROCESS

 THE PROGRAM ALGORITHM ASSUMES EXACTLY THE SAME CRITERIA AS
                  PROPOSED BY WILSON

    OUTPUT MAY BE PREDETERMINED, TO EITHER A PRINTER GRAPH
       OR TO A SEQUENTIAL FILE FOR USE IN OTHER WAYS. IF
            REQUIRED, BOTH OUTPUTS MAY BE OBTAINED.

      LINE PRINTER OUTPUT IS SCALED AUTOMATICALLY, EITHER;
      0-100 MPa OR 0-200 MPa BASED ON THE ABUTMENT STRESS

   FILE OUTPUT IS TO THE CHOSEN FILENAME ON DD2:[GROUPHOME]
  THIS DIRECTORY ALSO CONTAINS THE PROGRAMME, A DOCUMENTATION
      FILE AND A LAYOUT TABLE FOR TRANSFERRING SEQUENTIAL
   FILE DATA TO THE PROPRIETARY PACKAGE 'RS/1' FOR HANDLING
       REFER TO THE RS/1 DOCUMENTATION FOR ASSISTANCE

     THE OUTPUT FILES MAY BE ACCESSED BY THE  PRINT FILES'
        UTILITY OR ANY COMPATIBLE USER WRITTEN SOFTWARE
```

THERE IS NO ERROR HANDLING IN THIS PROGRAMME. SO PLEASE
BE CAREFUL TO TYPE ONLY THE RESPONSES INDICATED TO PREVENT
PREMATURE TERMINATION

APPENDIX B

LINE PRINTER OUTPUT FOR EXAMPLE CITED IN TEXT

STRESS DISTRIBUTION IN THE RIBSIDE

****

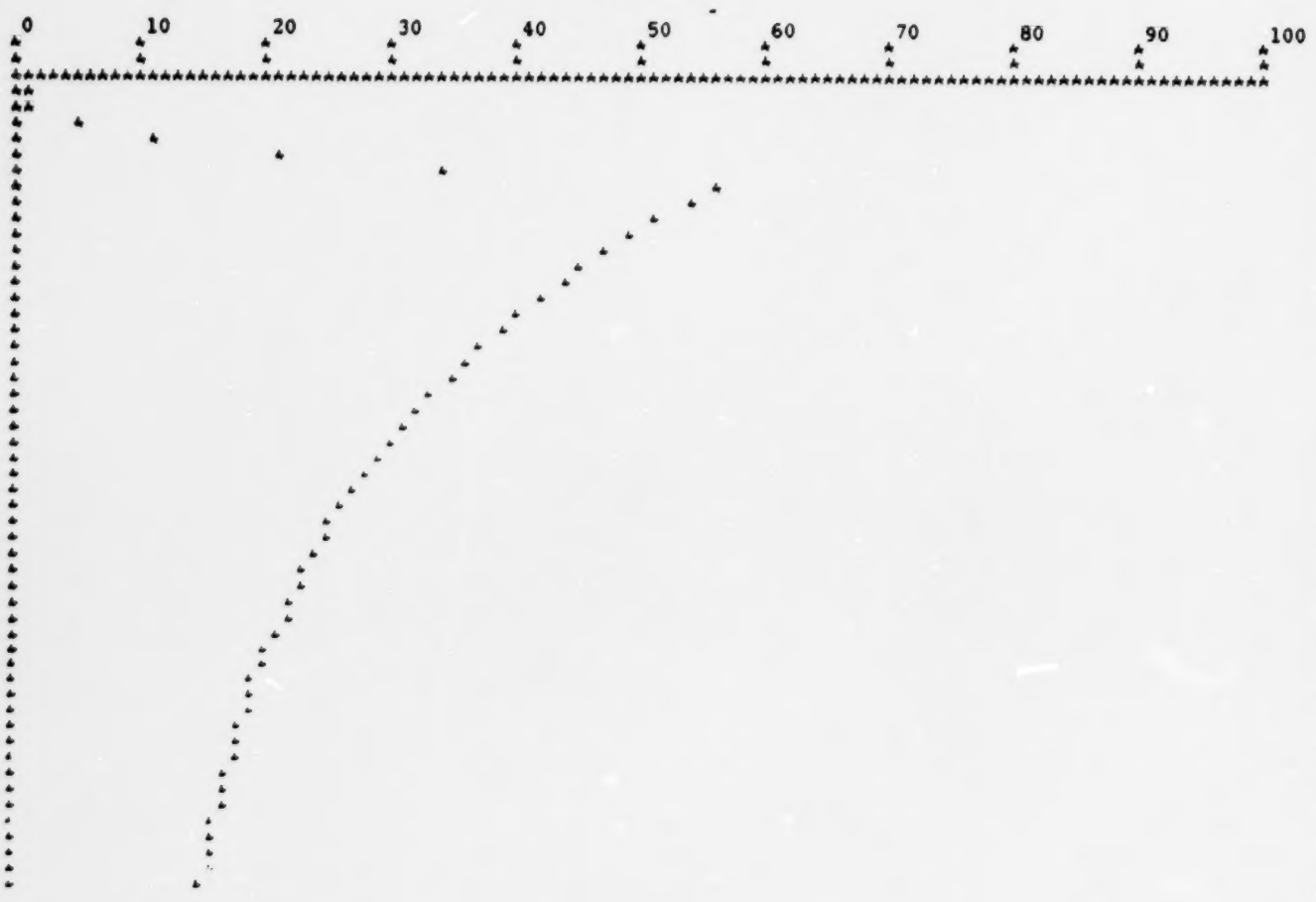
PARAMETER	VALUE
DENSITY	.025506 MPa/m^3
DEPTH	500 m
WIDTH	200 m
EXTD. HT.	3.6 m
COAL STR. (I)	35 MPa
COAL STR. (F)	.2 MPa
LAT SUPP RES	.1 MPa
STR FACTOR	5
STRESS FCTR	4

***** YIELD IN COAL ROOF AND FLOOR *****

CALCULATED VALUES

****

PARAMETER	VALUE
VIRGIN STRESS	12.753 MPa
YLD ZN WIDTH	5.84177 m
ABTMNT STRS	58.012 MPa
DECAY FCTR (C)	18.2846



X	SIGX
0	.666667
1	2.50937
2	6.27252
3	12.642
4	22.3036
5	35.9433
6	52.632
7	55.3391
8	53.3721
9	50.8325
10	48.8058
11	46.887
12	45.0703
13	43.3503
14	41.7219
15	40.1801
16	38.7204
17	37.3383
18	36.0298
19	34.791
20	33.6181
21	32.5079
22	31.4562
23	30.4608
24	29.5184
25	28.6268
26	27.7838
27	26.9874
28	26.2354
29	25.5072
30	24.8284
31	24.1857
32	23.5774
33	23.0017
34	22.4572
35	21.9423
36	21.4557
37	20.9961
38	20.5623
39	20.1531
40	19.7675
41	19.4044
42	19.0629
43	18.7421
44	18.4412
45	18.1594
46	17.8961
47	17.6504
48	17.4219
49	17.2098
50	17.0136
51	16.8329
52	16.6671
53	16.5158
54	16.3786
55	16.2551
56	16.1448
57	16.0475

APPENDIX C

LISTING OF FILE OUTPUT

(USING PROGRAMME DEFAULT PARAMETERS)

0.000.	0.667
1.000.	2.509
2.000.	6.273
3.000.	12.642
4.000.	22.304
5.000.	35.943
6.000.	53.442
7.000.	51.475
8.000.	49.602
9.000.	47.821
10.000.	46.125
11.000.	44.512
12.000.	42.977
13.000.	41.515
14.000.	40.125
15.000.	38.801
16.000.	37.542
17.000.	36.344
18.000.	35.203
19.000.	34.118
20.000.	33.085
21.000.	32.102
22.000.	31.166
23.000.	30.276
24.000.	29.429
25.000.	28.623
26.000.	27.855
27.000.	27.125
28.000.	26.430
29.000.	25.769
30.000.	25.140
31.000.	24.541
32.000.	23.971
33.000.	23.429
34.000.	22.913
35.000.	22.421
36.000.	21.954
37.000.	21.509
38.000.	21.086
39.000.	20.683
40.000.	20.299
41.000.	19.935
42.000.	19.587
43.000.	19.257
44.000.	18.943
45.000.	18.643
46.000.	18.359
47.000.	18.087
48.000.	17.830
49.000.	17.584
50.000.	17.351